

# M \* A \* T \* H COLLOQUIUM

Wednesdays 4 p.m. ❖ Darwin 103 ❖ Coffee, Tea & Cookies @ 3:45 p.m.

Sonoma State University Department of Mathematics and Statistics presents a series of informal talks open to the public.

*"Mathematics is the process of turning coffee into theorems"* Paul Erdős

- Aug 31 Using Knot Theory to Understand DNA Packing in dsDNA Viruses and in Trypanosomes** **Javier Arsuaga, San Francisco State University**  
Understanding the basic principles that govern chromosome organization poses one of the main challenges in mathematical biology of the postgenomic era. In this talk I will show how knot theory can be used to understand the three dimensional organization of the bacteriophage genome (an important model for some viruses) and of the mitochondrial genome of trypanosomes. We have developed experimental protocols, computational methods and analytical results to analyze these knots and shown that they are informative of the organization of the genome inside the virus. I will present packing models that have been derived from these knots as well as the mathematical questions that this biological problem has generated.
- Sept 7 The Mathematics of Crime Hotspots** **George Mohler, Santa Clara University**  
Crime is not evenly distributed across space and time, as some neighborhoods in a city have a disproportionate number of criminal events. Theories for the spread of social disorder, such as the broken windows hypothesis and repeat victimization, offer qualitative explanations for how these crime "hotspots" form and persist. In this talk we will show how these theories can be translated into mathematical models that provide a more quantitative picture of how small scale criminal behavior might lead to large scale hotspot pattern formation. We also will discuss how models of crime hotspots are currently being used for the purpose of predictive policing.
- Sept 14 Calculating the Kauffman Polynomials of Pretzel Knots** **Kathy Zhong, Sacramento State University**  
We will go over some basics such as knot diagrams, Reidemeister moves, and banded knots; then we will define the Kauffman polynomials and give examples of how to calculate the polynomials. At last we will compute the Kauffman polynomials of pretzel knots using the Kauffman skein method and give a closed formula for the Kauffman polynomial of a pretzel knot. Our calculation can be implemented in Mathematica and Maple.
- Sept 21 Dimensional Analysis** **Joe Tenn, Professor Emeritus, Physics and Astronomy, Sonoma State University**  
We will describe how physicists make use of the fact that physical quantities must have the right dimensions to reduce the number of equations in a problem or even to learn something about the solution without solving the classical or quantum equation of motion. We will encounter the most famous example—the yield of an early nuclear bomb test—and scientists Edgar Buckingham and Geoffrey I. Taylor.
- Sept 28 Tropical Atmospheric Waves: Theory, Asymptotic Methods, and Open Problems of Relevance to the Climate System** **Joseph Biello, UC Davis**  
I will present some observations regarding large scale phenomena in the tropical atmosphere. These are essentially large scale waves with a lot of small scale behavior embedded in them. The objective of my research is to try to understand these waves by making simplified models which are derived in a systematic fashion from first principles—i.e. the equations of fluid dynamics. This systematic method is called "multi-scale asymptotic analysis" and I will show how we used such a procedure to derive simplified equations for two such phenomena. I will also talk about open problems in the field in which students can participate.
- Oct 5 Young Tarski** **James T. Smith, Professor Emeritus, San Francisco State University**  
Alfred Tarski (1901–1983) perfected our framework for research in mathematical logic. For decades, as a Berkeley professor, he was the preeminent figure in that field. I'll describe his upbringing and early career in Poland, emphasizing the extreme political and social turmoil and contrasting his environment with yours. Then I'll depict Tarski's dual roles in geometry, as mathematical researcher and Warsaw schoolteacher. I'll note where needed historical work is underway, in collaboration with Andrew and Joanna McFarland. (Andrew is a Sonoma State Mathematics alumnus.)
- Oct 12 The Pea and the Sun and Other Paradoxes** **Tracy Hamilton, Sacramento State University**  
I have always enjoyed paradoxes. One of my favorites is the Banach-Tarski Paradox (also known as the pea and the sun paradox because it appears to be a proof that a ball the size of a pea could be decomposed and put back together again—in a finite number of steps—to create a ball the size of the sun). In this talk I'll discuss the Banach-Tarski paradox and some of my other favorites. I will also give some examples of how I use paradoxes in my teaching.
- Oct 19 Is the US Executing Too Many People? Or Too Few?** **Steven Cuellar, Economics, Sonoma State University**  
This paper uses a cross section of state level data pooled from 1976–2006 to analyze deterrent effect of capital punishment on the murder rate. We examine how the murder rate per 100,000 people in each state is affected by the number of executions each year in that state along with controls for state level demographic characteristics.
- Oct 26 Is There Scientific Evidence for ESP (extra-sensory perception)?** **Michelle Norris, Sacramento State University**  
A large number of scientific studies have been conducted to determine if ESP exists. Using the most current data, a statistically significant ESP effect can be shown to exist using a statistical technique known as meta-analysis. In this talk, I will describe the commonly-used "ganzfeld procedure," explain what a meta-analysis is, summarize the results of a meta-analysis of 56 recent ganzfeld experiments, and report a new, as-yet unpublished finding from this meta-analysis. Whether you are skeptical or open-minded about ESP or are just interested in applied statistics, you're encouraged to come.
- Nov 2 How Did Native Americans Count?** **Rick Luttmann, Sonoma State University**  
Only a few of the cultures of the New World had writing systems, but virtually all had methods of counting. Most now use the Western decimal place-value system, but there are many other ways to count. We will examine several alternatives, including those used by the Incas, the Meso-Americans (the Mayans and Aztecs), the Eskimos, and the Native Californians.
- Nov 9 Combinatorics of CAT(0) Cube Complexes—How (Some) Robots Move** **Federico Ardila, San Francisco State University**  
A "cube complex"  $X$  is a space built by gluing cubes together. We say that  $X$  is "CAT(0)" if it has non-positive curvature—roughly speaking, this means that  $X$  is shaped like a saddle. CAT(0) cube complexes play an important role in applications (phylogenetics, robot motion planning). We show that, surprisingly, CAT(0) cube complexes can be described completely combinatorially. This description gives a proof of the conjecture that any finite  $d$ -dimensional CAT(0) cube complex  $X$  "fits" in  $d$ -dimensional space, and shows how to realize  $X$  as the configuration space of a robot. It also leads to an algorithm for finding the shortest path between two points in  $X$ , and hence to find the fastest way to move a robot from one position to another one under this metric.
- Nov 16 Applying Markov Chains to NFL Overtime** **Chris Jones, Saint Mary's College**  
The NFL recently changed its rules for games that go into overtime in the post-season. We will verify that the previous system provides a statistically significant bias to the team winning the toss and using Markov Chains we will show how the new rules appear to balance out that advantage. We will also look at other possible methods for deciding the winner in an overtime game that have been considered, and rejected.
- Nov 23 No Talk—Thanksgiving Holiday**
- Nov 30 Actuarial Science: A Risky Business** **Sean McRae, Delta Dental of California (and SSU Math Alum)**  
The profession of actuary will be examined, from its origin in a London shipyard to present day, including the certification process, job functions, growth opportunities, salary, and job satisfaction. Personal anecdotes about entering the workforce as a Sonoma State Graduate with a degree in mathematics will end the talk.



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